ANZCOR Guideline 13.5 – Tracheal Intubation and Ventilation of the Newborn

Summary

ANZCOR Guidelines 13.1 to 13.10 and the Newborn Life Support algorithm are provided to assist in the resuscitation of newborn infants. Differences from the adult and paediatric guidelines reflect differences in the anatomy and physiology and the causes of cardiorespiratory arrest for newborns, older infants, children and adults. These guidelines draw from Neonatal Life Support 2020 and 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations (CoSTR), [1, 2] the development of which included representation from ANZCOR. The 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Care [3] and local practices have also been taken into account.

To whom do these guidelines apply?

The term 'newborn' or 'newborn infant' refers to the infant in the first minutes to hours following birth. In contrast, the neonatal period is defined as the first 28 days of life. Infancy includes the neonatal period and extends through the first 12 months of life.

ANZCOR Guidelines 13.1 to 13.10 and the Newborn Life Support algorithm are mainly for the care of newborns. The exact age at which paediatric techniques and in particular, compression-ventilation ratios, should replace the techniques recommended for newborns is unknown, especially in the case of very small preterm infants. For term infants beyond the first minutes to hours following birth, and particularly in those with known or suspected cardiac aetiology of their arrest, paediatric techniques may be used. (Refer to Paediatric Advanced Life Support ANZCOR Guidelines 12.1 to 12.7).

Who is the audience for these guidelines?

ANZCOR Guidelines 13.1 to 13.10 and the Newborn Life Support algorithm are for health professionals and those who provide healthcare in environments where equipment and drugs are available (such as a hospital). When parents are taught CPR for their infants who are being discharged from birth hospitals, the information in Basic Life Support Guidelines (ANZCOR Guidelines 2 to 8) is appropriate.

Recommendations

The Australian and New Zealand Committee on Resuscitation (ANZCOR) makes the following recommendations:

1. A decision to perform tracheal intubation will depend on the gestation of the infant, degree of respiratory depression, response to facemask (or supraglottic airway) ventilation, and the skill and experience of the resuscitator. Preterm gestation or very low birth weight should not be the only factor that drives the decision to intubate. Tracheal intubation may need to be performed; if ventilation via a facemask (or supraglottic airway) has been unsuccessful (heart rate remains low, oxygen saturation falling or failing to rise) or prolonged, in special circumstances, such as congenital diaphragmatic hernia, or extremely low birth weight, or newborns born without a detectable heartbeat, consideration should be given to intubation as soon as possible after birth. [Good Practice Statements]
2. Endotracheal tube (ETT) internal diameter in millimetres (mm) can be calculated as gestational age in weeks divided by 10. Typically, a 2.5 mm tube is appropriate for infants <1kg weight, a 3.0 mm tube for infants weighing 1 to 2 kg, a 3.5 mm tube for infants weighing 2 to 3 kg, and a 3.5 or 4.0 mm tube for infants over 3 kg. [Good Practice Statements]
3. A laryngoscope with a straight blade (size 1 [10 cm] for term infants and larger preterm infants, size 0 [7.5 cm] for preterm infants < 32 weeks' gestation or 00 [6cm] for extremely low birth weight infants) is preferred. Some experienced operators use curved blades. [Good Practice Statements]
4. The approximate depth of insertion of the endotracheal tube from the middle of the upper lip, in centimetres, can be calculated as weight in kg plus 6 cm. However, the following table is likely to result in greater precision. Use the recommendations in the table for extremely low birth weight infants and preterm infants after the newborn period. [Good practice statement, NHMRC LOE IV.]

Corrected gestation (weeks)	Actual weight (kg)	ETT mark at lip (cm)
23–24	0.5–0.6	5.5
25–26	0.7–0.8	6.0
27–29	0.9–1.0	6.5
30–32	1.1–1.4	7.0
33–34	1.5–1.8	7.5
35–37	1.9–2.4	8.0
38–40	2.5–3.1	8.5
41–43	3.2–4.2	9.0

Table: Recommended ETT length to the nearest 0.5 cm by corrected gestation (gestation at birth plus postnatal age) and weight at time of intubation.

5. Appropriate depth of insertion must always be verified by comparing the markings on the tube with the formula or table. [Good Practice Statement]
6. If the chest does not move and the heart rate does not increase, the location of the endotracheal tube and technique of ventilation need to be re-evaluated. A colorimetric CO_2 detector, attached to the endotracheal tube adaptor, is recommended as the most reliable method to confirm endotracheal tube placement in neonates who have spontaneous circulation. [Good practice statement, NHMRC 2015 LOE IV 2015]

However, false negative readings may occur in infants if there is very low or absent pulmonary blood flow so if the chest wall is moving well in a very depressed infant, some caution is needed to avoid unnecessary extubation and reintubation. [Good practice statement, NHMRC LOE IV 2015.]

7. Devices to monitor gas flow and volume have been shown to improve mask ventilation technique in simulation training and there is limited evidence of feasibility in clinical settings. However, to date, there is insufficient evidence of clinical benefit, so ANZCOR suggests against the routine use of flow and volume monitoring or end tidal CO_2 monitoring during newborn resuscitation. [CoSTR 2015, weak recommendation, low certainty of evidence]
8. ANCOR suggests that a supraglottic airway should be considered during resuscitation of the term and near-term newborn (>34 weeks, approximately 2000 grams) if facemask ventilation is unsuccessful. [CoSTR 2015, weak recommendation, low certainty of evidence]
9. In particular, a supraglottic airway should be considered as an alternative to tracheal intubation if facemask ventilation is unsuccessful and tracheal intubation is unsuccessful or not feasible. The supraglottic airway may be considered as a primary alternative to a facemask for positive pressure ventilation among newborns weighing more than 2000 grams or delivered ≥34 weeks' gestation, although there is insufficient evidence to support its routine use in this setting. A size 1 supraglottic airway is suitable for newborns up to 5 kg. [Good Practice Statement]
10. Effectiveness of ventilation should be checked using signs similar to those used for endotracheal ventilation (chest wall movement, improvement in heart rate, improvement in oxygenation). In addition, the chest should be auscultated. [Good Practice Statement]

Abbreviations

Abbreviation	Meaning/Phrase
ANZCOR	Australian and New Zealand Committee on Resuscitation
CoSTR	International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations
LOE	Level of evidence
NHMRC	National Health and Medical Research Council

Guideline

1 Tracheal Intubation and Ventilation

1.1. Indications

A decision to perform tracheal intubation will depend on the gestation of the infant, degree of respiratory depression, response to facemask (or supraglottic airway) ventilation, and the skill and experience of the resuscitator. Preterm gestation or very low birth weight should not be the only factor that drives the decision to intubate.

Tracheal intubation may need to be performed;

- if ventilation via a facemask (or supraglottic airway) has been unsuccessful (heart rate remains low, oxygen saturation falling or failing to rise) or prolonged
- in special circumstances, such as congenital diaphragmatic hernia, or extremely low birth weight
- for newborns born without a detectable heartbeat, consideration should be given to intubation as soon as possible after birth.

[Good Practice Statement]

1.2 Laryngoscope and endotracheal tube size and depth of insertion

Endotracheal tube (ETT) internal diameter in millimetres (mm) can be calculated as gestational age in weeks divided by 10. Typically, a 2.5 mm tube is appropriate for infants <1kg weight, a 3.0 mm tube for infants weighing 1 to 2 kg, a 3.5 mm tube for infants weighing 2 to 3 kg, and a 3.5 or 4.0 mm tube for infants over 3 kg. [Good Practice Statement]

A laryngoscope with a straight blade (size 1 [10 cm] for term infants and larger preterm infants, size 0 [7.5 cm] for preterm infants < 32 weeks' gestation or 00 [6cm] for extremely low birth weight infants) is preferred. Some experienced operators use curved blades. [Good Practice Statement]

The approximate depth of insertion of the endotracheal tube from the middle of the upper lip, in centimetres, can be calculated as weight in kg plus 6 cm.[4] However, the following table is likely to result in greater precision.[5] Use this table for extremely low birth weight infants and preterm infants after the newborn period. [Good practice statement NHMRC LOE IV 2015]

Corrected gestation (weeks)	Actual weight (kg)	ETT mark at lip (cm)
23–24	0.5–0.6	5.5
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33–34	1.5–1.8	7.5
35–37	1.9–2.4	8.0
38–40	2.5–3.1	8.5
41–43	3.2–4.2	9.0

Table: Recommended ETT length to the nearest 0.5 cm by corrected gestation (gestation at birth plus postnatal age) and weight at time of intubation.[5]

Appropriate depth of insertion must always be verified by comparing the markings on the tube with the formula or table (see also "Verification of endotracheal tube position" below). [Good Practice Statement]

1.3 Equipment to Prepare for and Perform Endotracheal Intubation

- T-piece resuscitator (or flow-inflating bag) and self-inflating bag (approximately 240 mL)
- neonatal facemasks (range of sizes suitable for premature and term newborn infants)
- Medical gases:
    - a source of medical oxygen (reticulated and/or cylinder, allowing flow rate of up to 10 L/min) with flow meter and tubing
    - a source of medical air plus air/oxygen blender

  Suction apparatus and suction catheters (6Fr, 8Fr, and either 10Fr or 12Fr)
- Laryngoscopes with neonatal blades (size 00, 0, 1) plus spare bulbs and batteries. Ensure end light is bright
- Endotracheal tubes (sizes 2.5, 3,3.5, and 4mm internal diameter). Important characteristics of the tube include:
    - uniform diameter, without a shoulder
    - no eye
    - uncuffed
    - standard curve
    - clear or translucent
    - radio-opaque
    - centimetre markings along the length to indicate depth of insertion
- Endotracheal stylet or introducer (optional for oral intubation, not used for nasal intubation)
- Supplies for securing endotracheal tubes (e.g., scissors, tape)
- Neonatal stethoscope
- Exhaled CO_2 detector
- Magill neonatal forceps (optional)

1.4 Ventilation technique

Considerations are similar to those for ventilation via a facemask (Refer to ANZCOR Guideline 13.4).

1.5 Verification of endotracheal tube position

The effectiveness of ventilation via an endotracheal tube is confirmed by three observations, which tend to occur in the following sequence;

1. chest moves with each inflation
2. increase in the heart rate to above 100 beats per min
3. oxygen saturations improve.

If the chest does not move and the heart rate does not increase, the location of the endotracheal tube and technique of ventilation need to be re-evaluated.

Other signs to verify correct endotracheal tube position

- By visual inspection of the endotracheal tube passing through the larynx.
- Mist may condense on the inside of the endotracheal tube during exhalation.

- Colour change in a colorimetric end-tidal CO_2 detector. A CO_2 detector, attached to the endotracheal tube adaptor, is recommended as the most reliable method to confirm endotracheal tube placement in neonates who have spontaneous circulation. [6] [Good practice statement, NHMRC LOE IV 2015] However, false negative readings may occur in infants if there is very low or absent pulmonary blood flow [6] so if the chest wall is moving well in a very depressed infant, some caution is needed to avoid unnecessary extubation and reintubation. [Good practice statement, NHMRC LOE IV 2015] False positives may occur with colorimetric devices contaminated with adrenaline (epinephrine) or surfactant. [7]
- Symmetrical air entry over lung fields (upper chest) auscultated with a stethoscope.

Signs that the endotracheal tube is not in the trachea

- No chest movement with inflations.
- A heart rate <100 beats per minute that does not increase soon after intubation and inflation is started.
- No expired CO_2 detected.
- No improvement in oxygenation.
- The absence of breath sounds in the axillae.

The lack of symmetrical chest movement with adequate inflating pressure may indicate that the endotracheal tube is too far down. The depth of insertion should be checked.

Devices to monitor gas flow and volume have been shown to improve mask ventilation technique in simulation training and there is limited evidence of feasibility in clinical settings. However to date, there is insufficient evidence of clinical benefit, so ANZCOR suggests against the routine use of flow and volume monitoring or end tidal CO_2 monitoring during newborn resuscitation. [2] [CoSTR 2015, Weak recommendation, low certainty of evidence.]

2 Supraglottic Airways

ANZCOR suggests that a supraglottic airway should be considered during resuscitation of the term and near term newborn (>34 weeks, approximately 2000 grams) if facemask ventilation is unsuccessful. [2] [CoSTR 2015, weak recommendation, low certainty of evidence]

In particular, it should be considered as an alternative to tracheal intubation if facemask ventilation is unsuccessful and tracheal intubation is unsuccessful or not feasible. [2] [Good Practice Statement] The supraglottic airway may be considered as a primary alternative to a facemask for positive pressure ventilation among newborns weighing more than 2000 grams or delivered ≥34 weeks' gestation, although there is insufficient evidence to support its routine use in this setting. [2] A size 1 supraglottic airway is suitable for newborns up to 5 kg.

Effectiveness of ventilation should be checked using signs indicated above for endotracheal ventilation (chest wall movement, improvement in heart rate, improvement in oxygenation). In addition, the chest should be auscultated. For newborns receiving ventilation via a supraglottic airway the accuracy of colorimetric CO_2 detectors to confirm position and seal has not been reported. The supraglottic airway has not been evaluated during chest compressions.

References

1. Wyckoff MH, Wyllie J, Aziz K, de Almeida MF, Fabres JW, Fawke J, et al. Neonatal Life Support 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation. 2020;156:A156-A87.

2. Wyllie J, Perlman JM, Kattwinkel J, Wyckoff MH, Aziz K, Guinsburg R, et al. Part 7: Neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 2015;95:e169-201.

3. Aziz K, Lee HC, Escobedo MB, Hoover AV, Kamath-Rayne BD, Kapadia VS, et al. Part 5: Neonatal Resuscitation: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142(16_suppl_2):S524-s50.

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5. Kempley ST, Moreiras JW, Petrone FL. Endotracheal tube length for neonatal intubation. Resuscitation. 2008;77(3):369-73.

6. Aziz HF, Martin JB, Moore JJ. The pediatric disposable end-tidal carbon dioxide detector role in endotracheal intubation in newborns. J Perinatol. 1999;19(2):110-3.

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About this Guideline

Search date/s	ILCOR literature search details and dates are available on the CoSTR page of the ILCOR website (https://costr.ilcor.org) and the relevant CoSTR documents. [1, 2]
Questions/PICOs:	Are described in the CoSTR documents (https://costr.ilcor.org)
Method:	Mixed methods including ARC NHMRC methodology before 2017 and ILCOR GRADE methodology described in ILCOR publications since 2017.
Principal reviewers:	Helen Liley, Lindsay Mildenhall, Marta Thio and Callum Gately
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